PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : H04J 13/00, H04B 7/26

A1

(11) International Publication Number: WO 94/29980

(43) International Publication Date: 22 December 1994 (22.12.94)

(21) International Application Number: PCT/IB94/00158

(22) International Filing Date: 16 June 1994 (16.06.94)

(30) Priority Data:
P 43 19 830.9 16 June 1993 (16.06.93) DE

(71) Applicant *(for all designated States except US)*: PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(71) Applicant *(for SE only)*: PHILIPS NORDEN AB [SE/SE]; Kottbygatan 7, Kista, S-164 85 Stockholm (SE).

(71) Applicant *(for DE only)*: PHILIPS PATENTVERWALTUNG GMBH [DE/DE]; Wendenstrasse 35c, D-20097 Hamburg (DE).

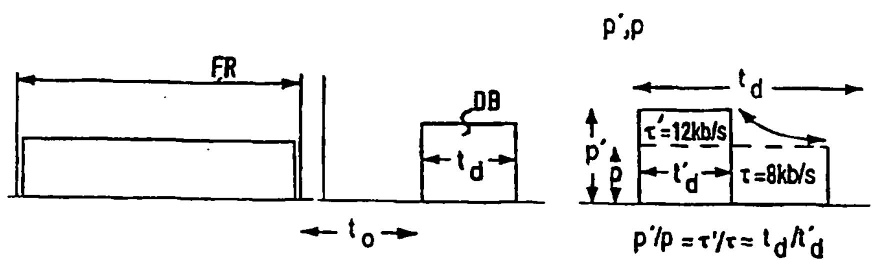
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: PANZER, Herbert [DE/DE]; Greuther Strasse 27, D-90455 Nürnberg (DE).

(74) Agent: DE JONGH, Cornelis, Dominicus; Internationaal Octrooibureau B.V., P.O. Box 220, NL-5600 AE Eindhoven (NL).

(81) Designated States: CN, JP, KR, RU, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: CDMA TRANSMISSION SYSTEM



(57) Abstract

The invention relates to a CDMA transmission system comprising at least a transmitter in which a data sequence is spread with a code sequence, and comprising at least a receiver in which the data sequences are recovered by means of a detector. To load only the frequency portion used having the necessary frequency bandwidth in CDMA transmission systems, a frame structure is proposed in which the payload to be transmitted in a frame is compressed to a signal burst. A burst in a frame is then characterized by a frame-relative initial instant t_o and a dedicated duration t_d.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgystan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo			SE	Sweden
CH	Switzerland	KR	Republic of Korea	SI	Slovenia
CI	Côte d'Ivoire	KZ	Kazakhstan	SK	Slovakia
CM	Cameroon	LI	Liechtenstein	SN	Senegal
CN	China	LK	Sri Lanka	TD	Chad
CS	Czechoslovakia	LU	Luxembourg	TG	Togo
CZ	Czech Republic	LV	Latvia	TJ	Tajikistan
DE	Germany	MC	Monaco	TT	Trinidad and Tobago
DK	Denmark	MD	Republic of Moldova	UA	Ukraine
ES	Spain	MG	Madagascar	US	United States of America
FI	Finland	ML	Mali	UZ	Uzbekistan
FR	France	MN	Mongolia	VN	Viet Nam
GA	Gabon				

CDMA transmission system

The invention relates to a CDMA transmission system comprising at least a transmitter in which a data sequence is spread by a code sequence, and comprising at least a receiver in which the data sequences are recovered by means of a detector.

The invention likewise relates to a receiver and a transmitter for a CDMA transmission system.

In a transmission system based on Code-Division Multiple Access (CDMA), the signals of different users are simultaneously switched in a common frequency band and switched with a common carrier frequency. Code-division multiple access systems are based on a spread band technique i.e. the signal to be transmitted is spread over a frequency band which is considerably broader than the least required frequency band for a signal transmission. The band spreading renders code-division multiple access systems generally highly resistant to interference.

For frequency band spreading in code-division multiple access systems each (payload) bit to be transmitted is multiplied by a codeword agreed upon by transmitter and receiver. For distinguishing between the bits of the payload data sequence to be coded, a bit of the codeword is generally referenced a chip. The use of suitable codewords excludes, in principle, mutual interference of the signals of the individual users.

For obtaining a specific bit error rate with CDMA technology, a given interference power requires a signal power that is approximately proportional to the transmit payload bit rate. In CDMA systems, in which the individual users use different payload bit rates depending on the application, for example, coded speech transmission, facsimile transmission, and so on, it is desirable for reasons of economic use of frequencies to load the CDMA transmission system only with the necessary frequency bandwidth.

For example, from WO 92/15164 such a CDMA transmission system is known in which a programmable clock generator is provided for obtaining a variable bandwidth, by means of which generator the chip clock rate of each selected codeword is predefined. The higher the chip clock rate is selected, the broader is the resultant bandwidth of the spread transmit signal.

For practical reasons the chip clock rates are selected to be integer

multiples of a basic clock rate. In the preferred embodiment of said Patent application the bandwidth is therefore 1.2 MHz or a multiple thereof.

It is an object of the invention to provide a CDMA transmission system which makes a very great flexibility of the system possible.

This object is achieved in that a frame structure is provided and in that the payload information to be transmitted in a frame is compressed to signal bursts.

The transmit data occurring in a frame can thus be concentrated into a burst, while the frame length-to-burst duration ratio indicates the attained compression factor. In this manner also very different and finely graded compression factors can be achieved. With very high payload data rates continuous transmission may be effected, as before, thus the overall frame length can be used as a burst, but, on the other hand, with low-rate payload data only a section of the frame is used.

A burst in a frame is characterized by frame-relative starting instant t_o and an associated duration t_a. These parameters can be selected to depend on the system or on the link, due to the selectable spreading, but, in addition, also be variably changed in a link. Suitable measures such as, for example, controlled predefinition of the starting instant t_o by the fixed station, or also random selection of the starting instant t_o for the sending station itself, may be achieved in that the frames are filled as uniformly as possible to present thus a balanced economic use of frequencies.

In a highly advantageous embodiment of the invention there is provided to select a spreading factor in dependence on an original payload data rate. It is then possible to project different payload bit rates on a constant output bit rate, a so-termed chip rate.

When the same payload information is to be transmitted in a condensed burst, the result is that the bit rate of the time-compressed payload data is increased in inverse proportion to the burst length-to-frame length ratio. To achieve the appropriate bit error rate for this increased bit rate, a further embodiment of the invention proposes to increase the power accordingly in proportion to the compression factor.

Briefly stated, the fact that spreading factors can be selected or even be variably set is used for exchanging power for burst duration, as required.

An essential characteristic feature of mobile radio based on CDMA is that especially in the transmit direction to the fixed station the signals, relating to the same payload bit rate, are to be received with the same power and the noise power of adjacent cells may only amount to a part of the total received power. In a link between, for example, small cells and superimposed large cells, this condition cannot be satisfied, because a

sufficient power adaptation in a small cell and the neighbourhood of the large-cell fixed station is impossible as a result of the considerably larger send power of the large cell.

Different operators will generally install their radio cells in uncoordinated fashion. This may lead to the following problems, in that the cell boundaries of one operator exactly coincide with the position of the fixed stations of the other operator. In such a case it will not be possible to effect a suitable power adaptation, because in each case, at least in a fixed station, the noise power will be considerably higher than the payload signal power.

To solve this problem the invention proposes to select a position t_0 of a beginning of a burst in dependence on the cell size. In this manner the burst ranges in which small cells operate can be separated from the ranges of the frames in which large cells operate. An interference owing to different transmit powers is then largely excluded. The limit between the bursts can be defined with the necessary safe distances determined by the situations, while the radio traffic ratio in the different cell categories (small cell to large cell, and so on) is the decisive parameter.

An extremely simple solution is provided if the frames for all the cell categories are synchronized, which, however, can be guaranteed with the suitable arrangement (for example, a mobile switching centre such as in GSM) and signalling links.

With different uncoordinated operators there would be impermissible interference, because a frame synchronization cannot be presupposed then. To solve this problem the invention proposes to determine a suitable and better usable time domain in a frame and per cell by measuring a field strength distribution in a frame in the fixed or mobile station.

Advantageously, the frame is subdivided for this measurement into time slots to which the measurement is related. The burst is then selected such that it covers, for example, n successive time slots in dependence on the information to be transmitted. A special variant is the allocation of exactly one time slot each time.

Mobile radio systems are based on a duplex transmission with the directions of downlink (fixed station to mobile station) and uplink (mobile station to fixed station). The two directions of transmission may be separated in the frequency domain (FTD) or in the time domain (TDD). Data services gaining in importance stand out in that the payload bit rates in the two directions may show extremely different values (asymmetrical links). Some of these links are implicitly taken into account in CDMA in that an adapted spreading factor is selected and transmission takes place with accordingly adapted power. However, if the asymmetry holds for entire cell environments, for example, because the

range of services especially comprises distribution services, different bandwidths from the radio resource are to be allocated to the two transmission arrangements. Let us assume that FDD is, for example, 500 kHz for the uplink and 4 MHz for the downlink. As frequency domains are generally subjected to a global planning, which is to take a multiplicity of users into account, this set-up is not very flexible.

In a further embodiment the invention proposes to separate directions of transmission (downlink/uplink) between transmitter and receiver as a function of time, while an element of time can be variably defined for each direction of transmission.

When a separation with time (TDD) is used, it is locally left up to the individual operator to what extent he uses his frequency band for the two directions of transmission. According to the basic principle it is possible that the burst length is variably adapted in accordance with the mean bit rates for the two directions (while, additionally, the necessary bit error rate is taken into account).

This adaptation cannot be performed separately for each individual link, because otherwise overlapping and thus impermissible interference occurs either on the side of the fixed station or the mobile station. This is not necessary either, because occasional exceptions are taken into account by a relatively adapted power. An overlapping may also be impermissible for adjacent cells, because either an adjacent fixed station (in so far it has a higher transmitter power than a mobile station) can interfere the reception of a mobile station, or the reception of the fixed station is interfered on the cell boundary by an adjacent-cell mobile station positioned in the vicinity. Therefore it is appropriate to coordinate a change of boundaries for the two directions by a suitable common controller as described hereinbefore. Apart from this, there is still the possibility of regarding neighbouring cells as uncoordinated and implementing the decentralized measuring method which has also been described hereinbefore.

It has already been observed that a pure CDMA system is not sufficient to realize a sufficient separation of the users in all cases. The invention has therefore proposed to make an additional separation in the time domain. The invention proposes as a further alternative to communicate temporarily in different frequency domains, for example, for performing a handover.

By compressing the payload data in at least two bursts having the same contents, it is possible in this way to transmit in a time-frame the same information both in a first frequency band and in at least a second frequency band in succession.

The invention will now be further described and explained on the basis of

the exemplary embodiments shown in the drawings, in which:

Fig. 1 shows a CDMA transmission system comprising a transmitter and a receiver;

Fig. 2a shows a frame structure of the CDMA system;

Fig. 2b shows the correlation between data rate, burst duration and received power;

Fig. 3 shows burst distribution in a frame in small cells and large cells;

Fig. 4 shows the situation of interference with local superpositioning for at least two CDMA systems in the same frequency band;

Fig. 5 shows the occupancy of a frame by bursts in a CDMA system having different not mutually synchronized users;

Fig. 6 shows an example of an application to asynchronous operation (different data rates for downlink and uplink);

Fig. 7 shows a situation of interference;

Fig. 8 shows the use of separate bursts for payload signal and pilot signal;

Fig. 9 shows the use of a plurality of pilot signals superimposed on the payload signal in the event of non-synchronized cells;

Fig. 10 shows the use of compression of payload data blocks for the creation of measuring time slots;

Fig. 11 shows the use of two transmitters for transmitting burst signals in different frequency bands when only a single receiver is needed; and

Fig. 12 shows the use of a single transmitter for transmitting burst signals in different frequency bands when two separate receivers are needed.

Fig. 1 shows a CDMA radio system, for example, a radio system for mobile communication, comprising a transmitter 1 and a receiver 2. Transmitter 1 and receiver 2 use a time frame FR (Fig. 2a) which is subdivided into equally long time slots (not shown). In each time slot a payload data block is transmitted. This presupposes the use of block-structured data, or the subdivision of a continuous payload data stream (for example, digitized speech signals) into data blocks having the same length in time. Depending on the data transfer rate of the original payload (for example, speech signal, facsimile data, alphanumeric messages, and so on), there are thus different-size data blocks available for transmission for each time slot of the transmit frame.

The payload PLD to be transmitted is applied in digitized form to a frame generator 11. A data stream arriving at the frame generator 11 can be buffered in blocks by

storage means before the data blocks are transferred to a subsequent spreader 12.

The processing and buffering of the block-structured data cause delays to occur. For these delays not to become perceptible in speech signals, a frame length of 10 ms was selected in the exemplary embodiment.

Each buffered payload data block can be compressed to a data block DB having a time duration of t_d, in that the frame generator 11 changes the data rate when the blocks are transferred to the spreader 12. This compressed data block DB will be referenced burst or CDMA-burst hereinafter to distinguish it from the payload data block.

In known fashion the data bits of the burst are spread in the spreader 12 by a multiplication by a multi-digit code word, so that with a subsequent modulation of the spread signal in a modulator 13, a signal is developed having an accordingly higher bandwidth than the signal that is not spread. This spread signal is subsequently subjected to a power control in a power control stage 14 before it is combined with other channels OCHH to a sum signal in a summation stage 15 and transmitted over an antenna 16.

The length in time t_d of a burst, the instant t_o referring to the start of a frame and also the transmitter power p_{tx} with which a burst is transmitted, are predefined values for the frame generator 11 and the power control stage 14 produced by a control unit 10. The transmitter power p_{tx} is controlled such that a specific received power p appears at the receiver 2. The transmitter power p_{tx} is controlled in such a way that a specific received power p is found at receiver 2. Advantageously, the transmitter power p_{tx} is to be selected so that the received power p is proportional to the selected data transfer rate τ of the transmit burst. This means that if the length in time t_d of a burst is selected to be shorter with the same payload block size, the control unit 10 is to select the transmitter power p_{tx} accordingly higher to guarantee an accordingly higher received power p (cf. Fig. 2b). With p', t'_d, and τ', a different received power, a different selected data transfer rate and a different length in time are indicated, respectively. In the example given, $\tau = 8$ kb/s, and $\tau' = 12$ kb/s.

In the receiver 2 the signal mixture received *via* an antenna 21 is distributed over the individual signal processing circuits by a signal distributor 22. One such signal processing circuit is provided for each receive channel or subscriber, respectively. In each signal processing circuit the signal is first demodulated in a demodulator 23 and de-spread in known fashion in a de-spreader 24. The distinction between channel and subscriber is made here by the use of the code word used at the transmitter end. In a decoder 25 the original payload signal PLD is reconstructed from the received bursts.

An essential characteristic feature of a suitable mobile radio system based

on CDMA is that at a fixed station the signals from the individual subscribers, with regard to the same payload bit rate, are ideally to be received with substantially the same power, to guarantee optimum separation of the individual signals. Furthermore, the signals received from adjacent cells, which signals will collectively be denoted noise power in the following, form only part of the total received power. This condition cannot be maintained in a CDMA radio system formed by large and small cells, because due to the considerably larger transmitter power of the large cell, an adequate adaptation of the power in a small cell located in the neighbourhood of the large cell is not possible.

Here the concept according to the invention can be used for defining, in a frame FR, at least a coverage area F_1 of their own for the small cells which are separated from at least coverage area F_2 for large cells (see Fig. 3). The payload signals from small and large cells are thereto compressed to bursts, so that they can be transmitted in the appropriate sub-frames F_1 and F_2, respectively.

The division into small cell burst and large cell burst causes the noise power received from a fixed station of a small cell to be restricted exclusively to other small cells, and the noise power received from a fixed station of a large cell to be restricted exclusively to other large cells. The bursts a, b, c of the small cells are transmitted at a lower data rate than the bursts X, Y of the large cells, while for the same data rates of the basic payload signals an accordingly longer burst period is provided, so that the transmission of the bursts a, b, c of the small cells needs only a relatively small transmitter power. As a result, the noise power received from other small cells is also small, even if the small cells are proximal cells. For the subscribers of the large cells, on the other hand, a higher compression rate with appropriately higher power can safely be selected, because the enlargement of a large cell provides an equivalent protection ratio in neighbouring large cells.

Fig. 4 shows another undesired noise situation in which two different operators A and B of two independent CDMA radio systems, which are to use the same frequency band, however, and distinguish the subscribers only by different codes, have receiver stations located in uncoordinated fashion. A worst-case situation may arise when the operator B has located his fixed station on the cell boundary of the radio cell of operator A. As a result, it will not be possible to effect a suitable power matching, because at any rate at least in a fixed station, the noise power caused by the other operator is considerably higher than the power of the payload signal of its own subscribers. An * indicates interference, in that when the sum of interference power ΣI is much greater than the sum of payload power

ΣP, this indicates that no control is possible.

A synchronization of all the operators in the event of mutually independent operators is very costly. A sub-frame for each operator, separate from the other operators, like the separation described hereinbefore of a frame for small and large cells, is therefore not always the most practical solution. Without a common frame synchronization, however, interference signals occur that cannot be permitted.

In a further embodiment there is assumed that the individual operators transmit their data preferably in equally long, but mutually independently selected frames FR. Preferably, the frames FR are subdivided into equidistant time slots, while each user operates in the burst mode *i.e.* uses one or more time slots with an accordingly higher transmitter power for transmitting the data of its subscribers. A use of the whole frame length is deliberately dispensed with. In this manner, unused or little-used regions occur in a frame. By measuring the field strength distribution in a frame, each fixed station of each operator and, optionally, also the mobile stations concerned can find unused time slots and select for transmission a number of successive vacant time slots in dependence on the information volume to be transmitted (see Fig. 5). The selection of data transfer rate and transmitter power makes it possible to adapt the data volume to be transmitted to the number of time slots available. An arrow AR1 indicates a burst seizing two consecutive time slots, and arrows AR2 and AR3 indicate seizure after measurement.

In a further embodiment, different payload bit rates are used for the transmission from fixed station to mobile station (downlink) and from mobile station to fixed station (uplink) (asymmetrical link). A rather large part of a frame is used for the direction that requires the higher payload data rate and the other part of the frame is used for the other direction. Since in this case the time-dependent limits of the sub-frames are preferably given a fixed value, it is possible, in the sub-frames to adapt the actually necessary payload data rates again *via* the transmitter power. For example, in Fig. 6, in which burst d needs to have a higher payload bit rate than bursts a, b and c, the transmitter power of the burst d for the downlink is selected such that it is received with an accordingly higher received power. The received powers of the bursts U, V, W, X for the uplink, on the other hand, are controlled, due to the corresponding data rates, so that they are received all with the same receiver power by the fixed station.

Preferably, the division into downlink and uplink sub-frames within the whole CDMA system is to be selected to be the same, as it may otherwise lead to interference situations shown in Fig. 7. In Fig. 7, operator B interferes due to higher

transmitter power, and band Y of indicated bands X and Y interferes due to proximity. With different widths of downlink and uplink sub-frames there would be an overlap in time of a part of the downlink sub-frame of a radio cell with a part of the uplink sub-frame of the other radio cell. In that case a fixed station could interfere its neighbouring fixed station, or mobile stations on the cell boundary transmitting with more power due to their maximum distance from their fixed station, could interfere a nearby mobile station of the neighbouring cell. It is thus also advantageous in this case to have a synchronized subdivision of downlink and uplink sub-frames within the whole CDMA system or, as already described before with respect to the simultaneous use of large and small cells, to have a subdivision of the frame into many time slots with a field strength measurement before a vacant time slot is occupied.

In a further embodiment there are at least several transmitters working with different frequency bands. For mutually distinguishing the individual radio cells there is a payload signal provided in certain embodiments which is transmitted by the individual transmitters. In this embodiment it may be necessary in the course of a call to change frequency bands, for example:

- If different cell categories have been assigned different frequencies, and during a call, a handover is to be effected, for example, from a small to a large cell. In that case the pilot signal of the large cell has a different frequency from the pilot signal just used in the small cell;
- CDMA frequency bands have a minimum of, for example, 500 kHz, because it is only there that a sufficient number of subscribers are simultaneously available to make an efficient use of the code superpositioning possible. For operators of small networks, defined, for example, by the uncoordinated use of cordless private branch exchanges (of which certainly a plurality of exchanges can be present in an office building), or, in an extreme case, defined as simple users of cordless telephones, the assignment of a frequency band to each operator is not efficient. These operators will then share frequency bands while there must be a possibility to change dynamically to another frequency band if the noise situation changes;
- There may also be a situation in which a handover to a neighbouring cell is desired, but this cell prefers to have a different frequency domain;
- In a CDMA system it is generally possible to use the same frequency range in a station's own cell and in neighbouring cells. However, this no longer holds if the spreading factor becomes small as a result of very high payload bit rates. In this case too it is necessary to change dynamically to other frequencies.

The change to another frequency has a twofold requirement:

- Measuring and identification activities, for example, the recognition of possible neighbouring fixed stations on the basis of the pilot signal with simultaneous field strength measurement, or a measurement of the noise power in a possible frequency domain for the handover.

- Exchange of signalling information. This may be effected as a so-called forward handover in which the exchange of information is already effected with the new frequency. This transition is fast, because from the transition onwards, payload can be transmitted already at twice the rate of the previous frequency and, in the other direction, when the handover is received correctly, a termination is effected by a terminated previous link. A characteristic feature here is that the link exists for a specific period of time with two frequencies. The advantage is that no payload is lost (seamless handover). The second possibility is that the signalling is to be carried out as much as possible with the old frequency. This method is slower, because mobile and new cells are first to be fully matched before a change-over can take place. The mobile station, besides receiving with the new frequency, however, is also to send with this new frequency to verify the uplink. This is to say that parallel transmission and reception activities are to take place with the new and old frequencies if the transmission of payload is to be effected seamlessly.

These considerations are analogously valid for the subdivision with respect to time. The difference is, however, that for the parallel operation of two time slots one transceiver will suffice, but not for two different frequencies.

However, more than one transceiver is a considerable increase of cost and current consumption, more specifically, in the mobile station. Therefore, the restriction to a single transceiver is to be desired at least for simple (telephone) mobiles. For the use as "cordless telephone" it may also be advantageous to use only one transceiver for the fixed station. This is considered an additional option. For the moment there is assumed that only the mobile station is restricted to a single transceiver.

Downlink considered

a) Identification of candidates for the change of cells.

In mobile radio systems there exists a reliable method of having each fixed station transmit its identification code (pilot signal) over a pilot channel. By measuring the power received from the pilot channels and decoding the identification codes, a mobile

then obtains the essential information for a change of cells. In a CDMA system the pilot channels are commonly separated by their codes and may, therefore, lie in the same frequency band. But, as described hereinbefore, there are exceptions in this respect: with different cell sizes and in uncoordinated environments of a plurality of operators. The pilot channels will then lie in different bands. A solution with only a single transceiver is found and shown in Fig. 8: payload and pilot information a, b, and c, and pil, respectively, is transmitted in time consecutive bursts. On the receiver side it should be possible when the payload is received to change the frequency band to receive pilot signals in different frequency bands.

The receiver of the mobile of Fig. 8 first receives the payload burst d from frequency band X and then changes its receiver, so that in the same time-frame it subsequently receives the pilot signal pil from frequency band Y. In Fig. 8 a relative power pr is indicated. The upper part of Fig. 8 relates to a transmitting situation in a large cell, the centre part of Fig. 8 relates to a transmitting situation in a small cell, and the lower part of Fig. 8 relates to a receiver in a mobile.

The embodiment shown in Fig. 8 is preferably to be used in a fully synchronized CDMA radio system. With a non-synchronized CDMA radio system an embodiment as shown in Fig. 9 is to be recommended. The pilot signals pil in the radio cells conveying a pilot signal are superimposed in consecutive bursts on the other payload signal bursts. The receiver, once it has received its payload signal burst, switches to the other frequency band to receive a pilot signal burst transmitted consecutively. To receive a complete pilot signal burst, the time slot provided for receiving the pilot signal burst should be at least twice as long as a pilot signal burst.

b) Identification of candidates for a change of frequency.

For this purpose, frequencies having the smallest possible field strength (and thus less expected noise power) are to be found. However, a condition is that the field strength does not fluctuate too strongly during a frame period (one may consider, for example, that in Fig. 8 another operator who does not use a pilot signal and happens to be synchronized) transmits with a certain frequency. There are two solutions:

- The transmitter powers for the two bursts are compared with a maximum. This is a waste of spectrum, or
- the bursts are adapted dynamically, so that a measurement may be made over the whole frame.

Fig. 10a shows an embodiment in which, for example, the transmission of payload data is effected over a full time-frame in the transmitter. In the next time frame the payload data block is then compressed to a burst, so that after reception of the burst there is ample time for the receiver to carry out measurements in other frequency bands for the rest of the time frame. A direct consequence of the compression of the payload data block is a higher transmitter power for the burst as is again apparent from Fig 10a. The upper part of Fig. 10a relates to a transmitter, an arrow AR4 indicating an increased data rate, and the lower part of Fig. 10a relates to a receiver, arrows AR5 and AR6 indicating measurement on other frequencies.

A derived embodiment is shown in Fig. 10b. In the second time frame both the payload data block for the second time frame and the payload data block for the third time frame are transmitted instead of the payload data block assigned to the second time frame, so that for the receiver the third time frame is fully available for measurements from then on. The upper part of Fig. 10b relates to a transmitter, an arrow AR7 indicating an increased bit rate, and the lower part of Fig. 10b relates to a receiver, an arrow AR8 indicating measurement.

c) Procedure of a seamless handover.

A transitionally overlapped transmission on the downlink can be achieved in that the payload of the previous link is concentrated in a part of the frame and is transmitted *via* a first transmitter TA (cf. the embodiment shown in Fig. 11). A second transmitter TB, which may belong to the same fixed station, but also to a different fixed station, concentrates the same payload in the complementary part. The use of two transceivers makes it possible to have the same transmitter powers over the whole frames, similarly to above. The subdivision of the frame may be variable. This may lead to achieving that if the former frequency is abandoned owing to, for example, overload, the transmitter power is to be slightly increased because of a slightly increased compression factor, whereas the new, still undisturbed frequency, is capable of handling more power and can therefore be loaded with a very high compression factor.

Uplink considered. In Fig. 11 a receiver R and further optional filler data FDTA are indicated.

The selection of candidates for the change of cells is omitted here.

a) Identification of candidates for a change of frequencies.

In simple duplex links with symmetrical payload there are certain correlations with respect to the noise power on the uplink or downlink, although large deviations occur due to the non-reciprocal situation of mutually interfering mobiles or fixed stations, respectively. The two directions of transmission present an independent behaviour only when strongly asymmetrical payload bit rates occur. At any rate the noise power with a frequency for the downlink is to be measured separately. No division with time is necessary here, because the fixed station is assumed to comprise a separate measuring receiver.

b) Procedure of a seamless handover

In this embodiment shown in Fig. 12 the mobile station transmits during the handover each consecutive transmit payload data block in a time frame both in the new frequency band Y and in the old frequency band X, T indicating a transmitting mobile. For this purpose, the payload data block is compressed accordingly, so that it can be transmitted twice per time frame instead of once per time frame. The compression in its turn requires accordingly increased transmitter powers. At the fixed station there is a separate receiver RA, RB for each frequency band X, Y, respectively. This twofold transmission is continued until the change of frequency has taken place at the fixed station. Previous links PLK1, and PLK2 in frequency band X, and new links NLK1 and NLK2 are indicated in Fig. 12, respectively.

Based on the motivation described above, the limit between the bursts is variable. An equalization of the transmitter powers over the whole frame is impossible, because the missing portion is necessary for the transmission with another frequency. The result is then a non-uniform distribution of noise power over one frame.

Combined approach to uplink and downlink.

In uncoordinated environments there cannot be excluded that the same frequency band is used for the downlink by one operator and as an uplink by another operator in the neighbourhood. In that case a non-uniform distribution of the noise power is to be taken into consideration at any rate for the two directions of transmission.

Only one transceiver also in the fixed station.

This may especially be cost-effective for cordless telephones as observed before. For the evaluation the situation outlined for the mobile is to be transferred to the

fixed station. The basic mechanisms have already been discussed.

Selective superpositioning

The possibility of parallel transmission with two frequencies can also be extended over a longer period of time. It is then possible to select, on reception, the signal having the better quality. The transmitter powers may be reduced and even to such an extent that the sum power averaged with time may become smaller than the transmitter power with one frequency as a result of diversity recovery. Simultaneous links with more than two frequencies are possible as an extension.

CLAIMS:

1. CDMA transmission system comprising at least a transmitter in which a data sequence is spread by a code sequence, and comprising at least a receiver in which the data sequences are recovered by means of a detector, characterized in that a frame structure is provided and in that the payload information to be transmitted in a frame is compressed to signal bursts.

2. CDMA transmission system as claimed in Claim 1, characterized in that a spreading factor is selected as a function of an original payload data rate.

3. CDMA system as claimed in one of the preceding Claims, characterized in that a position t_o of a beginning of a burst is selected in dependence on a cell size.

4. CDMA system as claimed in one of the preceding Claims, characterized in that a suitable and better usable time domain in a frame and per cell is determined by measuring the field strength distribution in a frame.

5. CDMA system as claimed in one of the preceding Claims, characterized in that for the separation of the directions of transmission between transmitter and the receiver a separation as a function of time can be made while an element of time can be variably defined for each direction of transmission.

6. CDMA system as claimed in one of the preceding Claims, characterized in that there is provided to communicate temporarily and simultaneously in different frequency domains.

7. Transmitter for a CDMA transmission system as claimed in one of the Claims 1 to 6.

8. Receiver for a CDMA transmission system as claimed in one of the Claims 1 to 6.

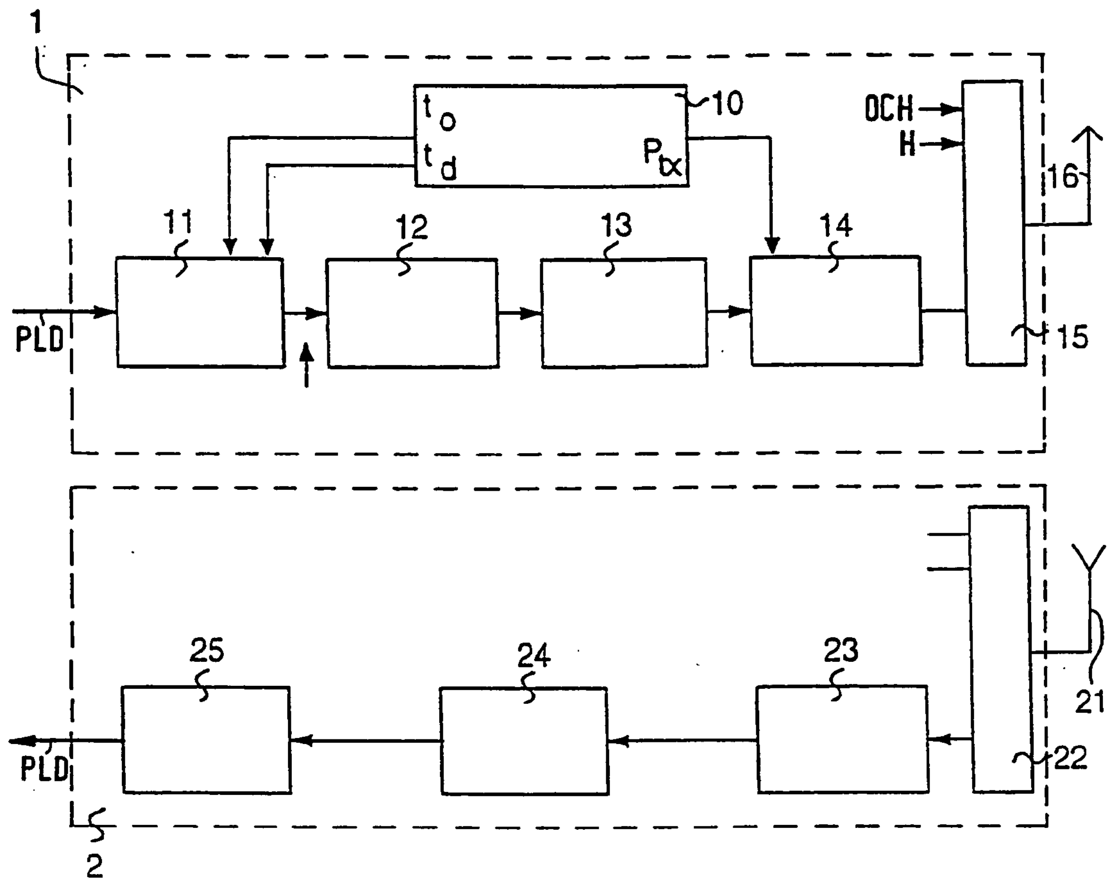


FIG. 1

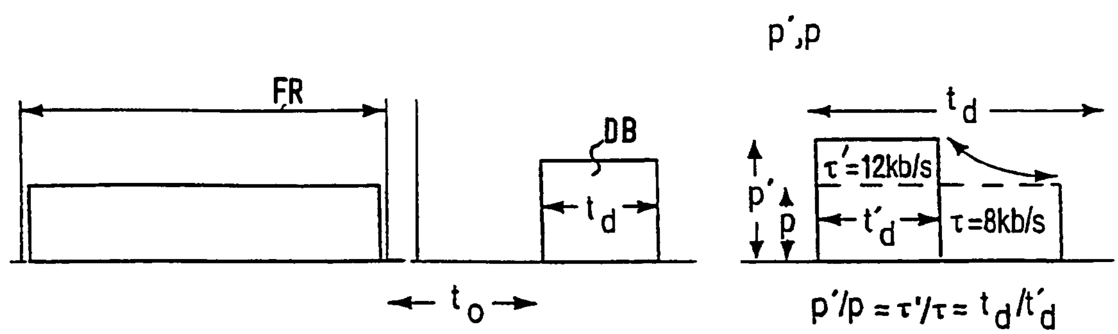


FIG. 2a FIG. 2b

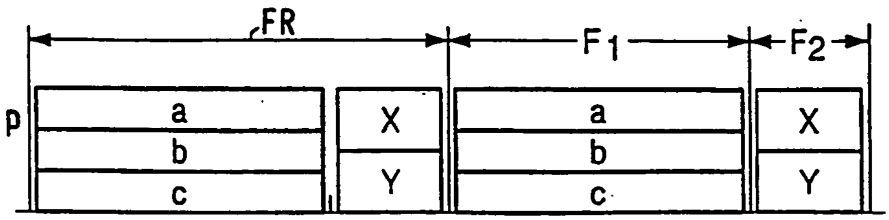


FIG. 3

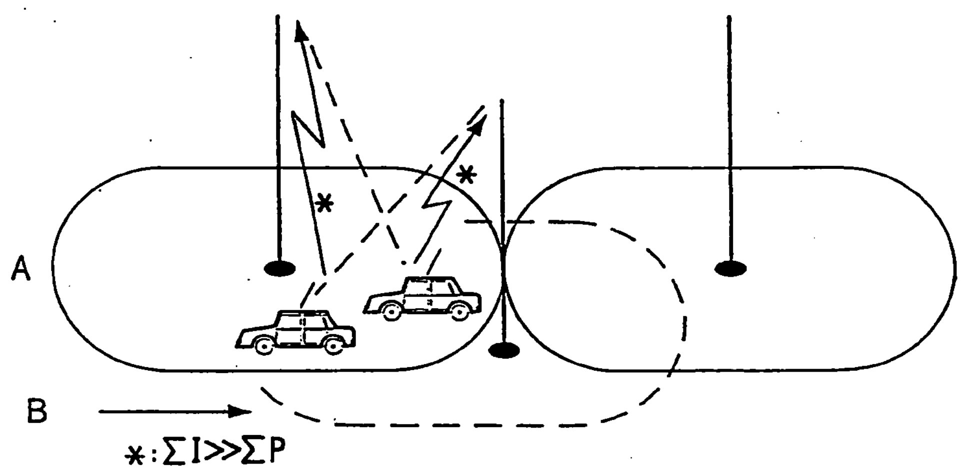


FIG. 4

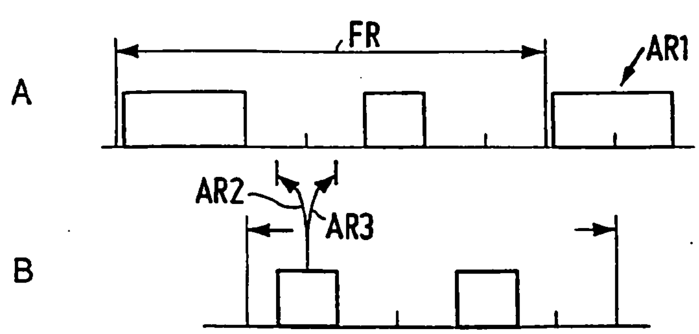


FIG. 5

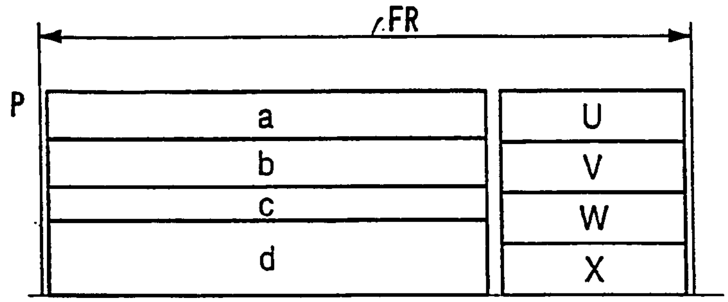


FIG. 6

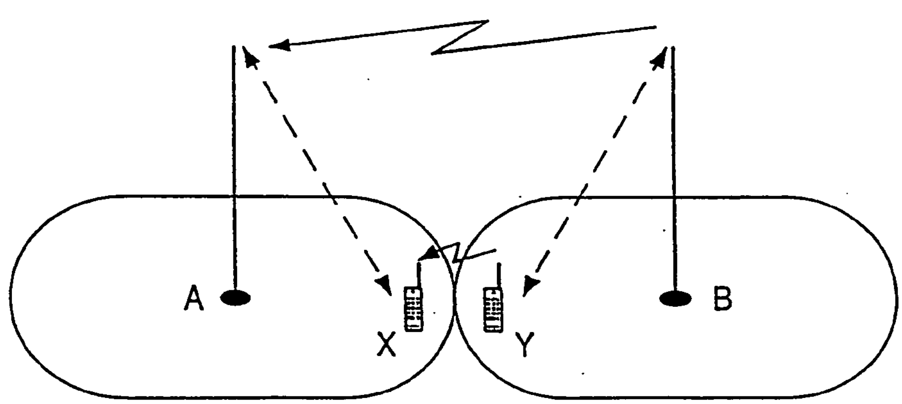


FIG. 7

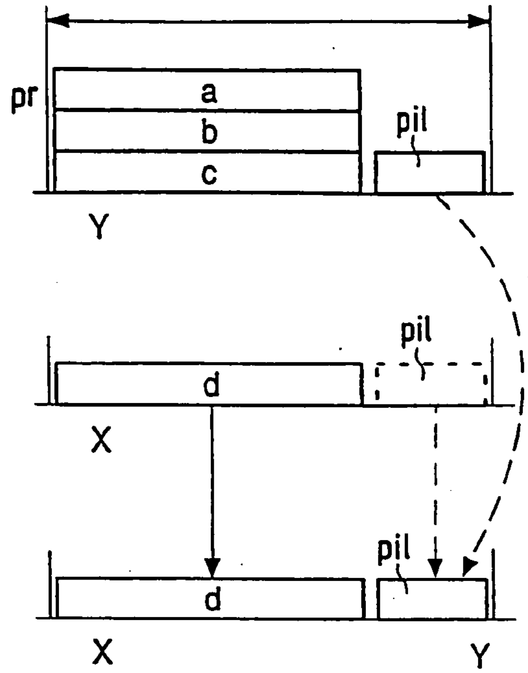


FIG. 8

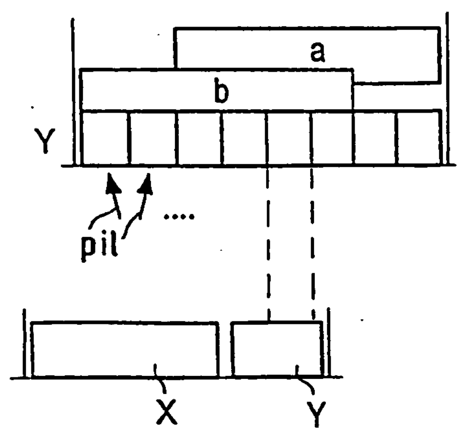


FIG. 9

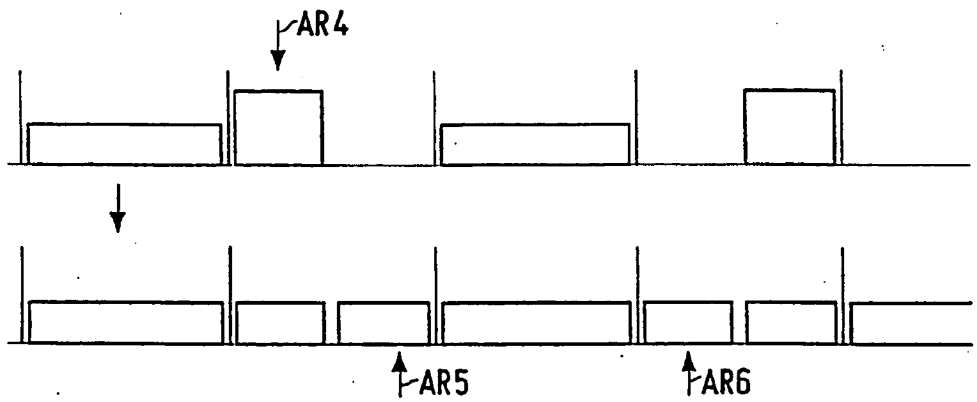


FIG. 10a

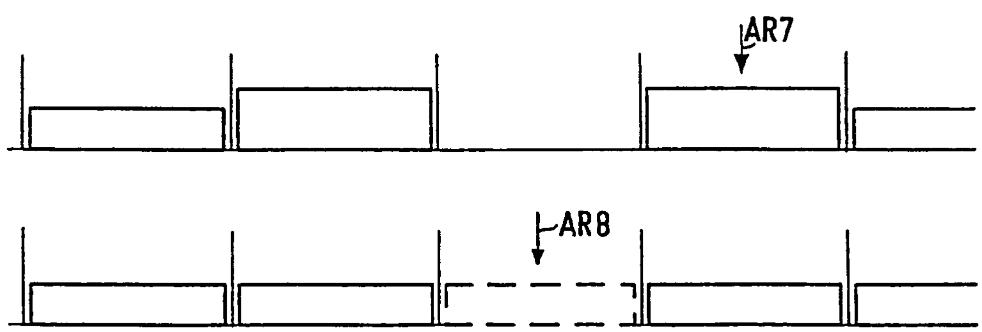


FIG. 10b

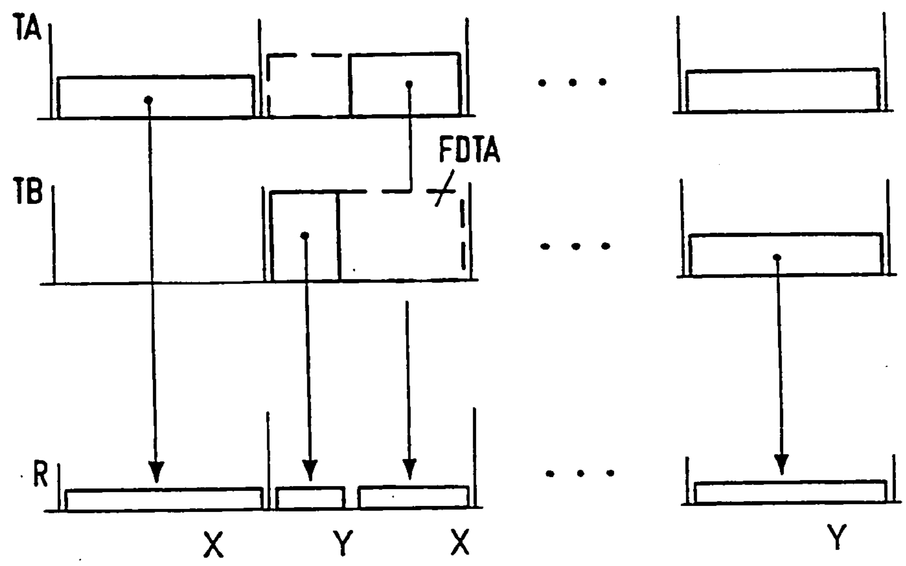


FIG. 11

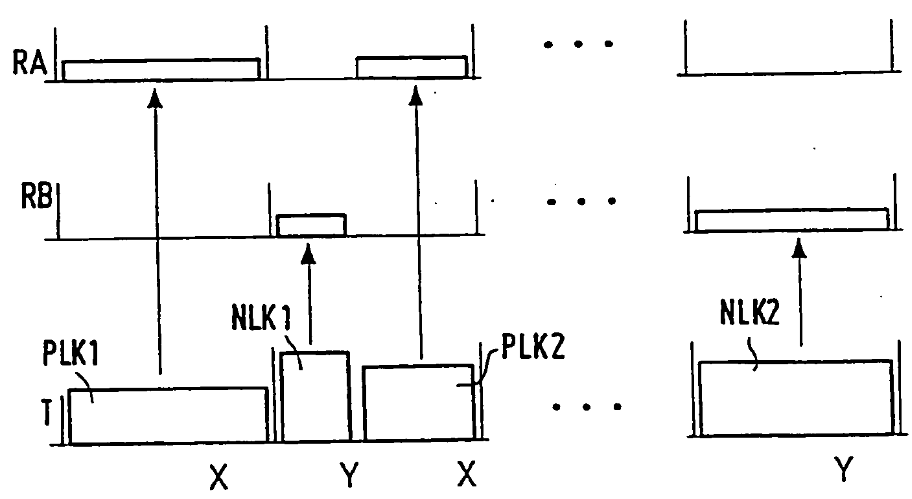


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 94/00158

A. CLASSIFICATION OF SUBJECT MATTER

IPC 5: H04J 13/00, H04B 7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 5: H04J, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, Vol 17,No 456, E-1418, abstract of JP, A, 5-102943 (NIPPON TELEGR & TLEPH CORP), 23 April 1993 (23.04.93)	1,2,8
A		3,7
	--	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" erlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 Sept 1994	06 -10- 1994
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bengt Jonsson Telephone No. +46 8 782 25 00